



Surgical Management of 3 and 4-Part Proximal Humerus Fractures with Locking Plates in Elderly

Yaşlı Hastalarda 3 ve 4 Parçalı Proksimal Humerus Kırıklarının Kilitli Plak ile Tedavisi

Proximal Humerus Fractures

Emrah Kovalak, Tolga Atay, Y. Barbaros Baykal, Özgür Başal
Department of Orthopaedics and Traumatology, Süleyman Demirel University Medical Faculty, Isparta, Turkey

Özet

Amaç: Proksimal humerus kırıkları tüm kırıkların yaklaşık %5'ini oluşturur ve bunların da %15-20'si deplase ve dengesizdir. Kilitli plakların ortaya çıkmasından sonra bu kırıkların osteosentez ile tedavisinde artış olmuştur. Ancak, hala bu kompleks kırıkların tedavisinde bir fikir birliği oluşmamıştır. Bu retrospektif çalışma ile yaşlılarda 3 ve 4- parçalı proksimal humerus kırıklarının kilitli plakla osteosentezinin fonksiyonel sonuçları ve prognozu etkileyen faktörleri değerlendirmeyi amaçladık. **Gereç ve Yöntem:** Çalışmaya 2010- 2015 yılları arasında deplase, 3 ve 4 parçalı proksimal humerus kırığı tanısıyla kilitli plak ile osteosentez yapılan 53 hasta dahil edildi. Kırıkların sınıflaması Neer Sınıflama sistemine göre yapıldı. **Sonuçlar,** Constant-Murley Skorlama sistemi (CMS), görsel analog ağrı ölçeği, ve düz radyografi ile değerlendirildi. Hareket açıklığının değerlendirilmesi amacı ile kolun öne elevasyonu ve abduksiyonu ölçüldü. **Bulgular:** 3 ve 4 parçalı kırıklar arasında, CMS, öne elevasyon ve abduksiyonda istatistiksel olarak bir fark saptanmadı ($p>0.05$). Ağrı 4 parçalı kırıklarda belirgin olarak daha fazla idi ($p=0.035$). CMS, öne elevasyon ve abduksiyon, yaş ve cerrahi süresinde gecikme ile ters yönde korale idi. Komplikasyon gelişen hastalar ile gelişmeyenler arasında CMS, öne elevasyon ve abduksiyonda istatistiksel olarak anlamlı farklılık saptandı ($p=0.029$, $p=0.017$ and $p=0.024$). **Tartışma:** Proksimal humerus kırıklarının kilitli plak ile tespiti sonrasında fonksiyonel sonuçlar; hastaya ait faktörler, kırık yapısı, cerrah ve implanta bağlı olmak üzere birçok faktörle ilişkilidir. Endikasyonlar dikkatli seçildiği takdirde 3 ve 4 parçalı proksimal humerus kırıklarının kilitli plaklarla osteosentezi iyi sonuçlar vermektedir.

Anahtar Kelimeler

Humerus Kırıkları; Proksimal; Omuz Kırıkları; Kırık Sabitlemesi; İnternal

Abstract

Aim: Proximal humeral fractures are approximately 5% of all fractures and, %15-20 is displaced and unstable. By the introduction of locking plates there used to be a substantial rise in the osteosynthesis of the 3 and 4-part proximal humeral fractures. But there is still a lack of consensus for the optimal treatment of these complex fractures. In this retrospective study, we aimed to evaluate the functional outcomes and prognostic factors of 3 and 4-part proximal humerus fractures treated with locking plate osteosynthesis in elderly. **Material and Method:** 53 patients with displaced 3 and 4-part proximal humeral fractures treated with locking plate osteosynthesis between 2010 and 2015 were included. The fractures were classified according to Neer classification system. Outcomes were assessed by Constant-Murley scoring system (CMS), visual analog pain scale and plain radiographs. In reference to range of motion, forward elevation and abduction of the arm were measured. **Results:** No statistically significant differences found between the 3- part and 4- part fractures in CMS, forward elevation and, abduction ($p>0.05$). Pain was significantly higher in 4-part fractures ($p=0.035$). CMS, forward elevation, and abduction were inversely correlated with age and delay in surgery. There was statistical significance between the patients had complications and those not in terms of CMS, forward elevation and, abduction ($p=0.029$, $p=0.017$ and $p=0.024$). **Discussion:** Functional outcomes of locking plate fixation of proximal humerus fractures are associated with patient related factors, fracture pattern, surgeon and, the implant. When indications are carefully selected, locking plate osteosynthesis yield good outcomes in surgical treatment of 3 or 4-part proximal humerus fractures.

Keywords

Angular Stable Plating; Humeral Fracture, Proximal; Locking Plates; Shoulder Fractures

DOI: 10.4328/JCAM.4834

Received: 12.10.2016 Accepted: 13.11.2016 Printed: 01.05.2017 J Clin Anal Med 2017;8(3): 243-7

Corresponding Author: Emrah Kovalak, Ortopedi ve Travmatoloji Anabilim Dalı, Süleyman Demirel Üniversitesi Tıp Fakültesi, 32260 Çünür, Isparta, Türkiye.

GSM: +905332346280 E-Mail: emrahkovalak@yahoo.com.

Introduction

Proximal humeral fractures account for approximately 5% of all fractures and usually affect women over 50 years old with osteoporosis [1-4]. The 15% to 20% of these fractures are displaced, unstable and may negatively affect vascular supply of humeral head [1,2]. In these cases, operative fixation is indicated and the surgical management is usually based on the personal experience and preference of the surgeon [1,5,6]. Various fixation options such as tension bending, intramedullary nailing and plate fixation or hemiarthroplasty had been recommended for the treatment of three, and 4-part fractures of the proximal humerus [4,7-10].

There is a certain consensus on prosthetic replacement of head - split fractures, but out of these, in 3 and 4-part fractures the surgical management based on personal experience [5].

By the introduction of locking plates there used to be a substantial rise in the osteosynthesis of the 3 and 4-part proximal humeral fractures [2,7,10-14]. These plates have some advantages over conventional plates such as, providing high stability allowing early rehabilitation because of angular stable construction and multidirectional locking screws anchored in humeral head, with less dissection of soft tissue and less compromising of periosteal vascularization [2,15-17]. Also, locking plates have superior biomechanical properties under rotational loads than locking intramedullary nails [12,14,18,19]. These specifications made them the preferred choice for the treatment of proximal humeral fractures in elderly, particularly those with osteoporosis [3,4,15,16]. Clinical series have demonstrated some success with the use of locking plates for two part fractures but their clinical utility for 3 and 4-part fractures remain unclear [10]. Still there is a lack of consensus for the optimal treatment of these complex fractures in the written literature [1,5,10,13]. Also, debate goes on patient's age or timing of the surgery on functional results that are managed with osteosynthesis [6,12,20-22].

With this retrospective study, we aimed to evaluate the functional outcomes and prognostic factors of 3 or 4-part proximal humerus fractures treated with locking plate osteosynthesis.

Material and Method

The retrospective analysis was undertaken on the patients who presented to our hospital between January 2010 and January 2015 with displaced, unstable 3-part and, 4-part proximal humeral fractures treated surgically with locking plate osteosynthesis. All fractures were classified according to Neer [9] classification system. Patient demographics such as age, gender, pre-operative hospitalization time, type of fracture and, union time were gathered from the patient records. Informed consent was obtained from all individual participants included in the study.

The method of surgical treatment was chosen according to the preoperative radiographs and CT images. Osteosynthesis was preferred for the patients not including the following parameters; articular surface fracture, head-split fracture, anatomic neck displacement > 2 cm, impaction of the head.

Patients were excluded if they had the following: multiple injuries to the same upper extremity or pre-existing upper extremity disability, pathologic fractures, American Society of Anes-

thesiologists (ASA) grades IV-V and age <50 years old.

All procedures were performed via the standard deltopectoral approach in the beach chair position by two trauma surgeons experienced on shoulder surgery.

After surgery, all patients were treated with same postoperative protocol. Patients were placed in a sling and were encouraged to start early passive range of motion (ROM) exercises and isometric deltoid, biceps and triceps strengthening on postoperative day 1 for 6 weeks. After 6 weeks patients began active ROM exercises in a formal physiotherapy program. Strengthening exercises began 3 months after the operation.

Patients were seen in follow-up at 3, and 6 weeks, 3, 6, and 12 months and assessed on their postoperative outcome by physical and radiological examination. Physical examination was used to determine ROM, pain and discomfort. AP shoulder and axillary views were obtained at each follow-up visit and evaluated for fracture healing, hardware positioning, and osteonecrosis.

Clinical outcomes were assessed at last follow-up visit using Constant-Murley scoring system (CMS; 0-100) [23] without correction for sex and age, and pain via visual analog scale (VAS). In reference to ROM, forward elevation and abduction were measured with long-arm goniometer.

Data were statistically analyzed using SPSS software (v15.0; SPSS Inc. Chicago, IL, USA). Categorical variables were reported as frequencies (percent), and continuous variables were reported as means ± standard deviations (SD). The groups compared for equality by means of an independent samples T-test for continuous variables. Mann-Whitney U test for two unpaired groups were used. Fisher's exact probability test was used for comparing categorical variables. Spearman's rank correlation was used when looking for statistical dependence between two variables. A p value <0.05 was considered to be statistically significant.

Results

Fifty- three patients were included in the study with an average follow -up time of 23 (15-60) months. The 38 (71.69%) of the patients were female with a mean age of 68.3±10.3, and, 15 (28.31%) were male with a mean age of 62.0±8.2. Average union time was 12 (10-16) weeks. Patients' demographics, pre-operative hospitalization and, union time are given in table 1. There were no statistically significant differences between the 3- part and 4-part fractures in terms of CMS, forward elevation

Table 1. Demographics of the patients		
Patients'	Osteosynthesis (n=53)	
Age†	Male	62.0±8.2
	Female	68.3±10.3
	Male	15 (28.31)
Sex n (%)	Female	38 (71.69)
	Right	29 (54.71)
Side n (%)	Left	24 (45.29)
Neer classification n (%)	3	37 (69.82)
	4	16 (30.18)
Total hospitalization time † (days)	9.5±5.4	
Follow-up time‡ (month)	23 (15-60)	

† Mean ±SD, ‡ Average with minimum and maximum values in brackets

and, abduction (Table 2). Pain was significantly higher, in 4-part fractures ($p=0.035$) (Table 2). CMS, forward elevation, and abduction were inversely correlated with age and pre-operative hospitalization time (Table 3).

Thirteen (24.5%) patients were sustained various complications; osteonecrosis of the humeral head in 3, screw perforation of the humeral head in 3, nonunion in 2, malunion in 3, subacromial impingement in 2 (Table 4).

Mean CMS of the patients who had complications was 58.72 ± 5.60 . When overall complications were enrolled there was statistical significance between the patients had complications and those not in terms of CMS ($p=0.029$).

The mean forward elevation of the patients who had complication was 128 ± 23.4 and abduction was 87 ± 21.6 . There were statistical significance between the patients had complications and those not in terms of forward elevation and abduction ($p=0.017$ and $p=0.024$).

There was no dominance of any complication in regards to the fracture type.

A 65 years male old patient with a 3- part fracture had non-union that required conversion to hemiarthroplasty 7 months after the operation, and the other 72 years old female patient with a 4-part fracture did not accept the revision surgery. These 2 patients were considered to be the part of the osteosynthesis group. Of the 3 patients (one 3-part, two 4- part) who had screw perforation, were underwent a second operation to reposition or remove the screw after the initial surgery. The patients

who had osteonecrosis had no secondary operation. The implant failure, screw breakage, infection, or nerve injury was not seen in the study.

Discussion

Surgical treatment of proximal humeral fractures are quite frequently performed procedure in clinical procedure [16]. These fractures usually occur by low-energy trauma in elderly and, manage surgically but generally considered as “surgery of failure” due to poor bone quality [4,16]. Additionally, poor bone quality arises arguments over the optimal treatment of these fractures, where as the functional outcome after treatment determines patient’s level of independence [10,21].

In the present study it was found that CMS and ROM were inversely affected by age and longer pre-operative hospitalization time in both 3 and 4- part fractures and, complications were related to the worse functional outcomes. However, there were no significant differences in functional results regard to fracture type, but pain was higher in 4- part fractures.

The affects of the fracture type on functional outcomes are various and, the complications are the major cause of decreased functional status in treatment of proximal humeral fractures [4,16,17,22]. Even though the fracture type not affecting the functional status in non-complicated patients, complication rate seems to be increased by fracture type (more complications in Neer type 4) [22]. Fracture types did not significantly influence the incidence of implant-related complications [24]. The 40% of the complications are seems to be related to the incorrect surgical technique that is mostly related to the experience [4]. Because of high complication rates in 4-part fractures, some authors recommend hemiarthroplasty to avoid second-er surgery despite to lower functional outcomes than locking plates [16,25].

Patient’s age negatively affects the functional results that are managed with osteosynthesis [6,20-22]. Anatomic reduction and restoration of the medial cortical support is harder and found related to the failure in elderly [26]. In the present study, older age and co- morbidities were related to the delay of the surgery and delayed surgery was found positively correlated with poor functional outcomes. Indirect effects of age on fracture such as lower bone mineral density, multifragmentary fracture pattern and age related patient compliance was also stated by Krappinger et al. [26].

Locking plate fixation is associated with some considerable complications [5]. Where as the complications such as avascular necrosis, primary screw perforation, secondary impaction, and secondary dislocation of greater tuberosity are not related to the plate, the complications such as secondary loss of reduction, secondary screw perforation, loosening, screw backing out, and breakage are stated as related to the plate and incidence of implant related complications increases in patients older than 70 years [24].

Avascular necrosis was reported as major and much feared complication in plate fixation, which was related to the worse outcomes and, leading major reason for further revision with secondary arthroplasty [2,5,10,15,17,27]. Locking plate configuration, the surgical technique and, soft tissue preservation allowed by the fixed angled construct lowers the AVN rates when

Table 2. Functional results of the fractures according to the fracture types.

	3-PART FRACTURE (n=37)	4-PART FRACTURE (n=16)	TOTAL (n=53)	p
Constant-Murley†	68.4±10.2	66.8±14.6	67.1±12.4	>0.05
VAS†	2.2±1.1	3.1±1.4	2.5±1.3	<0.05*
Forward elevation† (degree)	136±40.3	132±44.7	134±41.2°	>0.05
Abduction† (degree)	106±45.2	103±44.6	105±45°	>0.05

† Mean ±SD, *p<0.05 is statistically significant.

Table 3. Correlation of preoperative hospitalization time and age with functional outcomes and pain.

	Age		Preoperative hospitalization time	
	rho	p	rho	p
Constant- Murley	-0.507	0.003*	-0.410	0.005*
VAS	-0.170	0.253	-0.094	0.456
Forward elevation	-0.402	0.005*	-0.378	0.014*
Abduction	-0.390	0.007*	-0.410	0.004*

* p<0.05 is statistically significant

Table 4. Complications according to types of the fractures.

COMPLICATIONS	3-PART FRACTURE (n=5)	4- PART FRACTURE (n=8)	TOTAL (n:13)
Osteonecrosis	1	2	3 (5.66%)
Screw perforation	1	2	3 (5.66%)
Nonunion	1	1	2 (3.77%)
Malunion	1	2	3 (5.66%)
Subacromial impingement	1	1	2 (3.77%)

compared with the patients managed with conventional plates [1,24,27]. In some series, the patients in whom osteonecrosis developed had reasonable clinical outcomes and suggest that AVN was well tolerated in elderly population [5,10]. AVN is also well tolerated than malunion or nonunion [28].

Perforation of head screws primarily was one of the most frequent complications in this study with a rate of 5.66%. All of them were related to the initial surgery even with meticulous placement by intraoperative fluoroscopy. In the written literature, perforation of the head screws reported as the most common complication with a range of 2 to 40% with high revision rates [1,13,15,27]. Primarily perforation of head screws is probably related to purchase as much bone as possible coupled with spherical shape of the humeral head [27]. Egol et al. reported that, patients who had screw perforation were on average 6 years older than who had not, without any statistical difference [1]. In our serie, we did not have a correlation like this. Solberg et al. reported that the all screw perforations occurred in the superoposterior quadrant and resulted screw contact with the glenoid but, did not affected the functional results worse than the patients had no screw perforation in contrast with other series [10]. In the present study, we performed screw repositioning in 3 patients immediately in 48 hours after initial surgery, and according to us, they did not affect the functional outcomes.

Secondary screw perforation due to loss of reduction is another complication related to angular stable locking proximal humeral fractures and highly related to reoperations even though slight varus is accepted [5,24,27]. It is reported that missing medial support led to 30% screw perforations compared with 6% intact medial support [24]. It is stated that, the angular stable implant was responsible for screws cutting through osteoporotic humeral heads in elder patients and, was stated as 46% over 65 years old patients [5,21,24]. Anatomic reduction and restoration of the medial cortical support are crucial in order to prevent secondary varus angulation [14,26,27]. In the present study secondary varus angulation occurred in 2 without screw cut-out (Figure 1), where anatomic reduction was achieved and medial support screws were placed but tension band wiring was not performed. In fact tension band wiring was not used in any of the cases. Medial support screws have important contributions to the strength of the medial comminution and, also using of tension band wiring is recommended to neutralize the traction forces of rotator cuff when medial support is insufficient [24,29].

The non-union is another major complication in 3 or 4 -part

humeral head fractures [17]. In our series, non-union occurred in 2 (3.77%) patients and required to conversion to hemiarthroplasty and performed in one. In the written literature the rate of non-union is 2,7%- 8% and, related to soft tissue preservation, surgical technique [1,17]. And also complex structure of the fracture is another reason of non-union [21].

Subacromial impingement occurred with a rate of 3.77% in the present study due to high positioning of the plate. Patients did not accept revision surgery. In order to avoid this complication meticulous attention must be paid to correct placement, and use of positioning K-wires is recommended [24].

Retrospective design and, some lack of knowledge such as, the rotator cuff pathologies and functional status of the patients prior to surgery and the physiotherapy performed by the patients by themselves at home are the weak points of the present study.

In conclusion, functional outcomes of locking plate fixation of proximal humerus fractures are associated with many factors, which are related to the patient, fracture pattern, surgeon and the implant. According to our study and in the light of the literature when indications are carefully selected, locking plate osteosynthesis yield good outcomes in surgical treatment of 3 or 4-part proximal humerus fractures.

Competing interests

The authors declare that they have no competing interests.

References

- Egol KA, Ong CC, Walsh M, Jazrawi LM, Tejwani NC, Zuckerman JD. Early complications in proximal humerus fractures (OTA Types 11) treated with locked plates. *J Orthop Trauma* 2008;22:159-64.
- Ong CC, Kwon YW, Walsh M, Davidovitch R, Zuckerman JD, Egol KA. Outcomes of open reduction and internal fixation of proximal humerus fractures managed with locking plates. *Am J Orthop* 2012;41(9):407-12.
- Strohm PC, Helwig P, Konrad G, Südkamp NP. Locking plates in proximal humerus fractures. *Acta Chir Orthop Traumatol Cech* 2007;74:410-5.
- Ye T, Wang L, Zhuang C, Wang Y, Zhang W, Qiu S. Functional outcomes following locking plate fixation of complex proximal humeral fractures. *Orthopedics* 2013;36:715-22.
- Dai J, Chai Y, Wang C, Wen G. Meta-analysis comparing locking plate fixation with hemiarthroplasty for complex proximal humeral fractures. *Eur J Orthop Surg Traumatol* 2014;24(3):305-13.
- Giovale M, Mangano T, Rodà E, Repetto I, Cerruti P, Kuqi E et al. Shoulder hemiarthroplasty for complex humeral fractures: a 5 to 10-year follow-up retrospective study. *Musculoskelet Surg* 2014;98(suppl.1):S27-33.
- Demirhan M, Kilicoglu O, Altinel L, Eralp L, Akalin Y. Prognostic factors in prosthetic replacement for acute proximal humerus fractures. *J Orthop Trauma* 2003;17:181-8.
- Mighell MA, Kolm GP, Collinge CA, Frankle MA. Outcomes of hemiarthroplasty for fractures of the proximal humerus. *J Shoulder Elbow Surg* 2003;12: 569-77.
- Neer CS 2nd. Displaced proximal humeral fractures I. Classification and evaluation. *J Bone Joint Surg Am* 1970;52:1077-89.
- Solberg BD, Moon CN, Franco DP, Paiement GD. Surgical treatment of three and four-part proximal humeral fractures. *J Bone Joint Surg Am* 2009;91:1689-97.
- Fialka C, Stampfl P, Arbes S, Reuter P, Oberleitner G, Vecsei V. Primary hemiarthroplasty in four-part fractures of the proximal humerus: randomized trial of two different implant systems. *J Shoulder Elbow Surg* 2008;17:210-5.
- Min W, Davidovitch RI, Tejwani NC. Three- and four-part proximal humerus fractures: evolution to operative care. *Bull NYU Hosp Jt Dis* 2012;70:25-34.
- Maier D, Jaeger M, Izadpanah K, Strohm PC, Südkamp NP. Proximal humeral fracture treatment in adults. *J Bone Joint Surg Am* 2014;96:251-61.
- Ponce BA, Thompson KJ, Raghava P, Eberhardt AW, Tate JP, Volgas DA et al. The role of medial comminution and calcar restoration in varus collapse of proximal humeral fractures treated with locking plates. *Bone Joint Surg Am* DOI:10.2106/ JBJS.K.00202.
- Jost B, Spross C, Grehn H, Gerber C. Locking plate fixation of fractures of the proximal humerus: analysis of complications, revision strategies and outcome. *J Shoulder Elbow Surg* 2013;22: 542-9.
- Matejčić A, Vidović D, Ivica M, Durdević D, Tomljenović M, Bekavac-Beslin M et al. Internal fixation with locking plate of 3- and 4-part proximal humeral fractures in elderly patients: complications and functional outcome. *Acta Clin Croat*

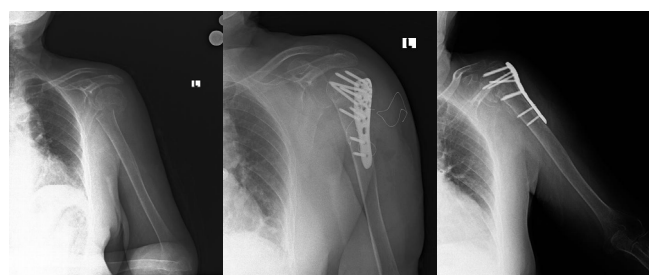


Figure 1. Plain radiograph of a 72 years old female patient with Neer Type 3 fracture (a). Immediate post-operative radiograph showing a satisfactory alignment and good fixation (b). Follow-up radiograph at the 8th month showing a varus collapse of the humeral head (c).

2013;52:17-22.

17. Parmaksizoglu AS, Sökücü S, Ozkaya U, Kabukçuoğlu Y, Gül M. Locking plate fixation of three- and four-part proximal humeral fractures. *Acta Orthop Traumatol Turc* 2010;44:97-104.
18. Foruria AM, Carrascal MT, Revilla C, Munuera L, Sanchez- Sotelo J. Proximal humerus fracture rotational stability after fixation using a locking plate or a fixed-angle locked nail: the role of implant stiffness. *Clin Biomech* 2010;25:307-11.
19. Micic ID, Kim KC, Shin DJ, Shin SJ, Kim PT, Park IH et al. Analysis of early failure of the locking compression plate in osteoporotic proximal humerus fractures. *J Orthop Sci* 2009;14:596-601.
20. Bastian JD, Hertel R. Osteosynthesis and hemiarthroplasty of fractures of the proximal humerus: outcomes in a consecutive case series. *J Shoulder Elbow Surg* 2009;18:216-9.
21. Leonard M, Mokotedi L, Alao U, Glynn A, Dolan M, Feringe P. The use of locking plates in proximal humeral fractures: Comparison of outcome by patient age and fracture pattern. *Int J Shoulder Surg* 2009;3:85-9.
22. Shahid R, Mushtaq A, Northover J, Maqsood M. Outcome of proximal humerus fractures treated by PHILOS plate internal fixation. Experience of a district general hospital. *Acta Orthop Belg* 2008;74:602-8.
23. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. *Clin Orthop Relat Res* 1987;214:160-4.
24. Brunner F, Sommer C, Bahrs C, Heuwinkel R, Hafner C, Rillmann P et al. Open reduction and internal fixation of proximal humerus fractures using a proximal humeral locked plate: a prospective multicenter analysis. *J Orthop Trauma* 2009;23:163-72.
25. Zhang AL, Schairer WW, Feeley BT. Hospital readmissions after surgical treatment of proximal humerus fractures: Is arthroplasty safer than open reduction internal fixation? *Clin Orthop Relat Res* DOI: 10.1007/s11999-014-3613-y.
26. Krappinger D, Bizzotto N, Riedmann S, Kammerlander C, Hengg C, Kralinger FS. Predicting failure after surgical fixation of proximal humerus fractures. *Injury* 2011;42:1283-8.
27. Thanasis C, Kontakis G, Angoules A, Limb D, Giannoudis P. Treatment of proximal humerus fractures with locking plates: a systematic review. *J Shoulder Elbow Surg* 2009;18:837-44.
28. Panagopoulos A, Tsoumpas P, Evangelou K, Georgiou C, Triantafillopoulos I. Late prosthetic shoulder hemiarthroplasty after failed management of complex proximal humeral fractures. *Adv Orthop* DOI: 10.1155/2013/403580.
29. Maddah M, Prall WC, Geyer L, Wirth S, Mutschler W, Ockert B. Is loss of fixation following locked plating of proximal humeral fractures related to the number of screws and their positions in the humeral head? *Orthop Rev* DOI: 10.4081/or.2014.5336.

How to cite this article:

Kovalak E, Atay T, Baykal YB, Başal Ö. Surgical Management of 3 and 4-Part Proximal Humerus Fractures with Locking Plates in Elderly. *J Clin Anal Med* 2017;8(3): 243-7.